High Pressure Cold Flow Injector Test

Project Number: 94-17

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Purpose

The objective of this project is to use cold-flow testing to compare the mixing efficiency of shear and swirl coaxial preburner injector elements. Mechanical sample collection method will be used to measure the distribution of the non-reacting simulants of liquid oxygen and gaseous hydrogen propellants.

Background

The performance, thermal environment, and combustion stability of liquid engines rely heavily on the operation of the injector. The design objectives for an injector are to break the liquid into sufficiently small droplets (atomization) with a uniform spatial distribution of the mixture ratio (mixing). These injector mixing characteristics can limit the combustor's efficiency. A variety of injector types have been used in an attempt to optimize atomization and mixing. The choice of an injector type for a specific application depends on several factors such as propellant combination, manufacturing cost, performance requirements, combustion stability characteristics, and the available experience base. The most common injector type used for second stage Earth-to-orbit applications is known as the shear coaxial injector.

In an attempt to understand the mixing characteristics of an injector, it is common to test single injector elements using nonreacting stimulants. Most data of this type have been taken at ambient back pressure. In the case of gas/liquid injection, these data in general are not scaleable to hot-fire conditions. Any attempt to obtain reasonable gas flow velocities will lead to a choked flow condition in the element, resulting in a complicated multidimensional compressible flowfield, very different from the low Mach number flow seen in a high-pressure combustor. In order to obtain a truly realistic comparison, the experiments need to be repeated at a higher back pressure.

Accomplishments

During this fiscal year, the mechanical patternator was installed into the test article, and the test readiness review was held in March. Preliminary checkout tests have been completed. The results of these can be summarized by figures 5 and 6.

The resistance for the fuel simulant is reasonably correlated to Reynold number of the flow where the resistance for the oxidizer simulant is not reasonable. Since these preliminary test results are based on the eight tests with one outlier, more checkout tests (particularly for the oxidizer stimulant) are desirable.

The test matrix is also revised based on the lesson we learned from John Hutt's work in Air Force's Phillips Laboratory. The eight test conditions are generated.

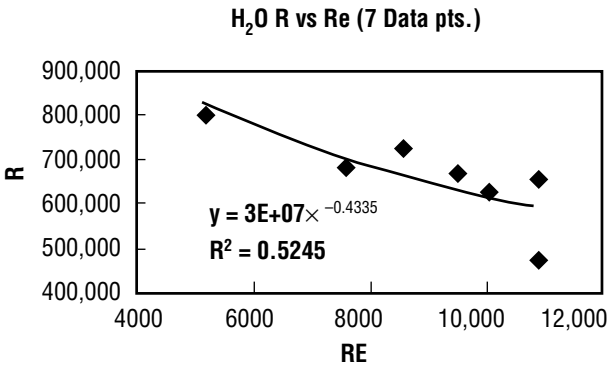

FIGURE 5.—Resistance of fuel simulant.

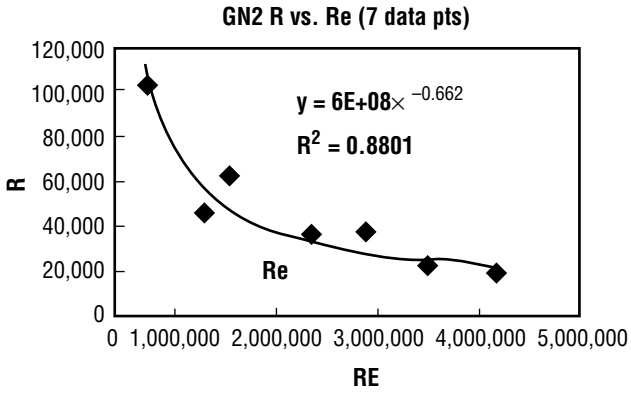

FIGURE 6.—Resistance of lox simulant.

Planned Future Work

The repeat of checkout tests are planned whenever the high priority works are finished at Test Stand 115. The tests for the predetermined test matrix will be conducted when the preliminary results are promising.

Funding Summary ($k)

	FY93	FY94	FY97
Authorized:	25	63	8
Obligated:	25	63	8

	FY98	Total
Authorized:	26	122
Obligated:	26	122
Balance:		0

Status of Investigation

Project approved—October 22, 1993

Estimated completion date—

- Repeat the check-out tests—December 30, 1997
- Shear injector test—February 28, 1998
- Change over to the swirl injector—March 30, 1998
- Change over to Mil-C and tests—May 31, 1998
- Repeat and reliability tests—July 31, 1998
- Report—September 30, 1998